MILLE LACS RESERVATION TRIP REPORT

Assessment of Mold and Moisture Conditions

Final Report

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INTRODUCTION

Anthony Corso from the Building Research Council (BRC) at the University of Illinois Urbana-Champaign and Paul Knight from Magna Systems, Inc. conducted a site visit at the Mille Lacs Reservation Housing Authority (MLRHA) on May 27- May 30, 2003. The MLRHA administers the housing program for the Mille Lacs Band of Ojibwe. The site visit provided technical assistance to the housing authority in assessing mold and moisture conditions in housing units. This report summarizes activities and issues addressed while on site. A detailed analysis of findings and recommendations is found in *PART II: Mille Lacs Reservation Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Mille Lacs Reservation.*

BACKGROUND INFORMATION

The Mille Lacs Reservation is located in Aitkin, Crow Wing, Kanabec, Mille Lac, and Pine counties in Eastern Minnesota. The region is home to hundreds of lakes, including Lake Mille Lacs which is the second largest lake in Minnesota covering an area of more than 200 square miles. The area is also comprised of miles of rivers, rolling forests, and marshlands. The average annual precipitation is 27.13 inches. The average annual snowfall is 45.1 inches. The average maximum temperature is 52.5 ° F and the average minimum temperature is 31.1° F. Approximately 2,908 Native Americans reside on the Mille Lac Reservation. The housing authority maintains more than 350 homes for the Band of which 115 are Low Rent and 15 are Mutual Help.

The assessment team responded to a request from the Eastern/Woodlands Office of Native American Programs to assess site and housing conditions contributing to mold and moisture problems at the Mille Lacs Reservation. Twenty homes were visited including Mutual Help, Low Rent, and under construction homes. The occupants were either not home or unavailable for an interview in seven homes. The twenty homes investigated included two, three, four, and five bedroom dwellings. Eight homes were built over crawl spaces, five homes were built with basements, six homes were built with half a basement and half a crawl space, and two were mobile homes. The primary source of heat in the majority of the homes was propane gas with an occasional combination wood stove and propane furnace system. The homes ranged in age from newly constructed to approximately thirty-five years old.

Day 1: Tuesday, May 27, 2003

The assessment team arrived at the MLRHA Office in Onamia, Minnesota on Tuesday afternoon. The team met with Toby Egan, Housing Inspector for the MLRHA, to discuss the day's activities, outline the team's role while on the reservation, and address the housing authority's concerns regarding the site visit. Toby Egan presented the specific

mold and moisture issues that the housing authority had been handling. The MLRHA selected the properties to be inspected and Toby Egan coordinated the logistics for the site visit.

Following the meeting, the assessment team, guided by Toby Egan, inspected two Low Rent homes in District 1 on the Mille Lacs Reservation.

Day 2: Wednesday, May 28, 2003

On Wednesday, the assessment, guided by Toby Egan, inspected two Low Rent homes and six Mutual Help homes in Districts 1 and 2 on the Mille Lacs Reservation. New homes under construction were also visited.

Day 3: Thursday, May 29, 2003

On Thursday, the assessment team, guided by Toby Egan, inspected 5 Low Rent homes and 1 Mutual Help home, plus two other homes with unidentified programs in District 3 on the Mille Lacs Reservation.

Day 4: Friday, May 30, 2003

On Friday morning the assessment team met with Toby Egan and Matt King, the Resident Services Supervisor, at the MLRHA Office to inspect two additional homes. The assessment team, accompanied by Toby Egan and Matt King, inspected a recently completed and unoccupied home to examine the construction and mechanical systems being used. The funding program for this home was not identified. The second home inspected was a Mutual Help home.

Digital photographs were taken to record conditions in all twenty homes. The inspection process also involved visual assessments of both interior and exterior conditions; various measurements pertaining to moisture content, relative humidity, infiltration, and air-flow; and discussions with available residents. *PART II: Mille Lacs Reservation Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Mille Lacs Reservation* provides a detailed analysis of findings and recommendations for the homes investigated on the Reservation.

Following the inspections, Anthony Corso, Paul Knight, Toby Egan, and Matt King met with Rick Boyd, the Housing Director, to discuss the assessment team's findings in the housing inspections.

FINDINGS

An overview of findings and recommendations for the site visit follows. *PART II: Mille Lacs Reservation Housing Authority Technical Housing Assessment Report* provides a more detailed discussion and analysis of the findings.

Mille Lacs Reservation

Principal findings from the site inspections include:

1. Rainwater Management Problems

    - Fourteen homes had site drainage problems (site grading).
    - Fifteen homes had problems with the roof rain water drainage system (gutters, downspouts, leaders, and splashblocks).

2. General Maintenance and Plumbing Problems

    - Nine homes had plumbing leaks and/or water damage from previous leaks.
    - Many homes had neglected maintenance issues regarding their mechanical systems.

3. Ventilation Problems

    - Many homes had problems with kitchen and bathroom exhaust fans.
    - In heavily used or overcrowded conditions, exterior venting fans are critical to avoid moisture problems.
    - Air-flow and circulation problems within conditioned spaces.
    - Many fans were nonfunctional or functioned below desired performance.

4. Homeowner/Tenant Education

    - Many tenants did not understand the functions and controls of their homes' mechanical systems and were not familiar with the required maintenance.

It should be noted that the MLRHA had addressed many of the above issues when the issues were brought to the housing authority's awareness. The new construction projects had also addressed the majority of the concerns expressed regarding earlier housing developments on the Reservation.

PROGRAMMATIC RECOMMENDATIONS

A particular challenge to all housing authorities is the development of a prompt and effective service delivery system to address mold and moisture conditions. This requires a partnership between the housing authority and residents. A system could be established that includes training for the maintenance staff on how to implement the technical recommendations and training for residents on their roles and responsibilities as homeowners and tenants. In many cases, moisture problems develop, but go unreported and unrepaired, which may result in significant mold contamination that could have been avoided. Some strategies to address this problem include:

1. Mandatory attendance at annual homeowner/tenant clinics as part of the annual recertification process. At these clinics, provide instruction on home maintenance issues, such as identifying and repairing leaks and maintaining gutters.

2. During the annual recertification process, ask occupants to complete a survey based on Housing Quality Standards (HQS) with additional questions on mold and moisture conditions in their homes. Completing the survey further engages residents in their own home maintenance. Furthermore, the survey responses provide additional information to the housing authority on unreported problems, especially leaks and inoperable fans that might contribute to an unsafe, unhealthy home environment.

PART II

MILLE LACS RESERVATION HOUSING AUTHORITY

TECHNICAL HOUSING ASSESSMENT REPORT:

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES OF THE MILLE LACS RESERVATION

EXECUTIVE SUMMARY

Twenty homes were inspected for mold and moisture problems for the Mille Lacs Reservation Housing Authority (MLRHA). The MLRHA administers the housing program for the Mille Lacs Band of Ojibwe. The investigation was conducted from May 27th through May 30th, 2003, by Paul Knight of Magna Systems, Inc. and Anthony Corso of the Building Research Council at the University of Illinois. Exterior and interior inspections were conducted at fifteen homes. Occupants were not home at another four homes and the occupants in a fifth home refused an inspection saying that they had no problems. Only exterior inspections were done for these five homes. The inspection process involved visual assessment of both interior and exterior conditions, air flow measurement of bathroom exhaust fans, whole house air leakage tests at three homes and resident interviews where possible.

Mold was found in eight of the fifteen homes that received both interior and exterior inspections.

Seventeen of the twenty homes had some type of site drainage problem. Fifteen of the twenty homes had some type of gutter/downspout problem.

Twelve of fifteen interior inspected homes had wet crawl spaces or basements. Two of these crawl spaces were flooded. All of the inspected crawl spaces had supply air ducts; five open supply registers were found on these systems. Eight return air ducts were found in eight crawl spaces; two return air grilles were found on these eight systems, also. All the crawl space foundation walls, excluding the two mobile homes and one site built home, were insulated to either R10 or R20. A mixture of vented and non-vented crawl spaces was found.

In addition, three homes under construction were inspected for energy efficient building practices, indoor air quality issues and potential mold and moisture problems.

Principal findings include:

1. Seventeen of the twenty homes had flat site drainage. Some of these had additional problems since they sat very low to the ground.

2. Fifteen homes had gutter system problems, ranging from no gutter systems to missing leaders. A recurring problem was that the occupants removed downspouts after installation by the MLRHA. The resulting rainwater management problems compounded the poor site drainage problems.

3. There was no consistent approach to crawl spaces. Crawl spaces should be treated as a conditioned space (heated and/or cooled), not as a combination of conditioned and non-conditioned spaces.

4. Bathroom exhaust fans were operating at half or less of the rated flow. A number of exhaust fans were either non-operational or were not exhausting any air. All bathroom exhaust fans vented to the outside.

5. Inspected attics were insulated to R30 with either batts or blown fiberglass insulation. No mold or water problems were found in any attics. All attics are well vented with a combination of ridge and soffit vents with insulation baffles installed over the top plate.

6. Plumbing leaks were found in eight inspected homes. A disconnected drain line had flooded one crawl space. All remaining plumbing issues were minor leaks or clogged drains.

7. Occupant lifestyles also contributed to moisture and other indoor air quality issues. Lifestyle issues include clutter in crawl spaces and basements, rugs in half basements, clogged fresh air intakes on ventilation systems and dirty furnace filters. Two out of three inspected HRV systems were turned-off.

8. The new homes constructed by the MLRHA appeared to be well built with energy efficiency and good indoor air quality high priorities.

The report provides technical recommendations and discussions focusing on these items. Appendix A includes a summary of findings at each inspected homes. Appendix B provides observations and recommendations for each home, excluding the unoccupied new homes under construction.

INTRODUCTION

The Building Research Council (BRC), under subcontract to Magna Systems responded to a request from the Eastern/Woodlands Office of Native American Programs to assess site and structural conditions contributing to mold and moisture problems in the Mille Lacs Reservation Housing Authority's (MLRHA) homes. The investigation was conducted from May 27th through May 30th, 2003, by Paul Knight (Magna Systems) and Anthony Corso (Building Research Council). Toby Egan of the MLRHA escorted the inspection team. The houses were pre-selected by MLRHA.

Twenty homes were inspected. However, five homes only received exterior inspections as the occupants were either not home or refused an interior inspection. Mold was found in eight of the fifteen homes that received both interior and exterior inspections.

Seventeen of the twenty homes had site drainage problems. Fifteen of the twenty homes also had some type of gutter/downspout problem.

Twelve of fifteen interior inspected homes had wet crawl spaces or basements. Two of these crawl spaces were flooded.

SECTION 1 – METHODOLOGY

Visual inspections were used to assess mold and moisture conditions in the homes.

Visual Inspection

Housing inspections consisted of the visual assessment of mold and moisture conditions. Assessment forms developed for the *Chicago Mold and Moisture Project* (a HUD Healthy Homes Program) were used to record information. The assessment forms are organized for a room-by-room inspection. All rooms were examined for water damage and evidence of mold. Assessment of kitchens, bathrooms, crawl spaces, utility rooms and attics included additional inspection relating to plumbing, localized ventilation, water entry and other moisture source issues.

The exterior of the houses were inspected for rain water management, including site grading, roof condition and gutter system.

Whenever possible, residents were interviewed to gather history on moisture problems, plumbing leaks, winter condensation, health issues, number of occupants and other useful information.

Digital photographs were taken at each house to visually record notable conditions.

Measurements

Moisture content measurements were taken of wood members in crawl spaces where moisture appeared to be a problem. Because of the moisture storage capacity of wood, moisture content measurements provide information on foundation and crawl space wetness in the recent past, perhaps three weeks to a month. Moisture content readings can range from 5%, indicating very low humidity, to 30%, indicating very high humidity.

Actual ventilation rates of bathroom fans were measured with an exhaust fan flow meter. The flow meter consists of a gasketed pan that is placed tightly over an operating exhaust fan. The pan has a variable orifice and a connection for a digital manometer. The cubic feet of air per minute (CFM) exhausted by the fan is calculated by measuring the pressure difference between the pan and the house during fan operation.

Air tightness of three homes was measured with a blower door. The blower door is a large fan that fits within a panel assembly (Figure 1). The assembly is fitted into an exterior doorway of a home. The house is set for winter conditions with the furnace and water heater turned off. The fan is adjusted to depressurize the house to minus 50 Pascals (Pa), which is equivalent to a 20 mile per hour wind on all sides of the house. The amount of air that the fan moved determined the air tightness of the home.

Figure 1 – Toby Egan setting-up the blower door

Air tightness is measured in units of cubic feet per minute of airflow at 50 Pa, typically referred to as CFM50. The smaller the airflow means the tighter the house. Existing homes exhibit a wide range of infiltration rates as measured by blower door tests, ranging from a low of 440 CFM50 to a high of 12,000 CFM50. The following standards provide additional information:

- In the Midwest, existing homes average about 3500 CFM50 before weatherization.
- The *Illinois Energy Efficient Affordable Housing Program* requires an air leakage rate no higher than 1100 CFM50 in its new homes.

The results of the mold and moisture assessments were compiled on a spreadsheet, with nine categories of common moisture problems noted. This data is presented in Appendix A of this report. Findings and recommendations for individually inspected houses are presented in Appendix B.

SECTION 2 – HOUSE DESCRIPTIONS

MLRHA manages 350 homes in three separate districts. An additional 300 new homes are planned by the MLRHA. Homes in all three districts were inspected during the site visit.

Twenty older homes and three homes under construction were inspected during the four day site visit. Most of the older homes were built between 1995 and 1999. Two homes were built in 1983 and had severe moisture problems. Of the older homes, eleven were ranch, seven were split level, and two were mobile homes. A few homes were modular construction. The new homes under construction were not occupied yet.

All the homes were 2" x 6" construction. Sidewall insulation could not be inspected and was assumed to be R19 fiberglass batts. Attics were insulated to R30 with fiberglass batts or blown fiberglass and were vented with a combination soffit and ridge vents.

All of the homes were built over crawl spaces. All but one of the crawl spaces was accessible from inside the home (excluding the mobile homes crawl spaces). One crawl space was accessible from the exterior of the home. The split-levels had crawl spaces and half basements. The half basements were finished with a bedroom, laundry room, bathroom and furnace room.

Foundations were either an insulated concrete form (ICF) system or concrete block. R10 extruded polystyrene insulation boards were used as the concrete forms for the ICF system. Concrete was poured between the insulation boards and the insulation forms were left in place. Above grade insulation on the exterior was covered with parging, a cement, water-proofing coating, or flashing. Interior insulation in crawl spaces was left exposed. The ICF system provided an R20 insulated foundation wall which helped maintain an elevated surface temperature in the winter and reduce condensation on the foundation walls during the summer.

Crawl spaces built with concrete block had exterior R10 foam board insulation. Except for the mobile homes, floors above the crawl spaces were not insulated.

Because of the duct work, the crawl spaces were conditioned with the insulated foundations. Open supply and return air grilles were found on the respective trunk lines in many of the crawl spaces. Some crawl spaces were vented.

Forced air furnaces (propane) are used for space heating. Furnaces are generally 80% efficient. Replacement furnaces and furnaces in the new homes are 90% efficient and are direct vent sealed combustion (Figure 2). Water heaters in existing homes are either natural draft propane or electric. Electric water heaters are being installed in the new homes. Many of the existing

Figure 2 – Combustion air intake – typical.

homes had 4" diameter combustion air intakes to the furnace rooms.

All the inspected homes under construction had or will receive heat recovery ventilation (HRV) systems. Some older homes were retrofitted with HRV's. Three homes had been retrofitted with these systems.

SECTION 3 – FINDINGS

3.1 Site Drainage

Site drainage was poor at 17 homes. Site drainage was either flat or pitched toward the foundation (Figure 3). Twelve of fifteen interior inspected homes had wet crawl spaces or half basements. One crawl space had approximately 6" of standing water. This house was sitting very low to the ground giving the appearance that it was built on a slab rather than over a crawl space (Figure 4). Five split level homes were inspected. These homes had finished living spaces in the half basement. Three of the five split level homes had visible mold in these living spaces. Two of these three homes were over 20 years old. Site drainage work had recently been completed around the basement area the third home.

The inspected homes under construction also had living space below grade. To avoid mold problems in the below grade spaces, proper site drainage must be maintained.

Figure 3 – Flat site drainage adjacent to home

3.2 Rainwater/Snow Melt Management

Fifteen homes had gutter system problems. Seven homes had no gutter systems. The other eight homes had problems ranging from missing downspouts and leaders to disconnected gutters. Downspout removal by the occupants appears to be a recurring problem at a number of the homes visited.

Figure 4 – House appears to be on a slab rather than a crawl space. About 6" of water was found in the crawl space.

Figure 5 – Rainwater is directed to rear of home.

Figure 6 – Mold on exterior in half basement

Figure 7 – Rainwater collects at base of house

The lack of properly functioning gutter systems compounds the site drainage problem and creates a potential mold problem as all of the rainwater and snow melt collects around the perimeter of the home (Figures 5, 6 & 7).

3.3 Crawl Spaces

Two crawl spaces had significant water problems. One house had 6" to 8" of water in the crawl space that appeared to be related to site drainage. In another crawl space, the drain line was disconnected and was also filled with a foul odor. These two crawl spaces were not inspected due to these conditions.

Wood moisture content readings were taken in six crawl spaces (Table 1). Moisture content readings can range from 5%, indicating very dry, to 30%, indicating very wet.

Table 1: Wood Moisture Content

House Number	Wood Moisture Content Reading	Moisture Problem
1-2	12%	• standing water in crawl space • very moldy gypsum board between crawl space and basement
2-3	13%	• -wet foundation walls and ground
2-4	6%	• crawl space was dry
2-6	7%	• wet ground in corner near sump pump
2-8	13%	• wet ground
3-1	16%	• wet ground/sweating pipes

A number of other problems related to site drainage and rainwater management as discussed above were found in the crawl spaces.

- **Thermal Boundary**

The thermal boundary is the building section that separates conditioned space from outside conditions. In many inspected homes no clear indication whether the crawl space walls or the floor above the crawl space was the thermal boundary. In three homes, the

floor above the crawl space was insulated, indicating that the floor was the thermal boundary. However, ductwork was located beneath the insulation and in two instances the ductwork was insulated. Two of the three crawl spaces were wet.

In twelve homes the crawl space walls were insulated with either 2" (R10) or 4" (R20) extruded polystyrene foam. Six crawl spaces were vented and six were not. All the crawl spaces, except one vented and one non-vented, were wet.

Figure 8 – Open supply register

- **Ground Covers**

Crawl space floors in three homes were concrete. The remaining floors were covered with a sand/dirt mixture. Displacement of this mixture exposed a polyethylene ground cover. However, it could not be determined if the ground cover was continuous which would have prevented ground water from moving up into the crawl space.

Figure 9 – Open return air grille in crawl space.

- **Ductwork/Plumbing**

Uninsulated ductwork and plumbing for the homes was located within the crawl spaces. All the crawl spaces had supply air ducts. Five of the twenty homes had open supply registers in these systems (Figure 8). Providing supply air to vented crawl spaces wasted energy dollars.

With regard to indoor air quality issues, the return air ducts found in eight of the crawl spaces were a great concern. Two return air grilles were found on these systems (Figure 9). Return air systems pull air into the distribution system. Thus, dirt, moisture and other contaminants are being pulled-in from the crawl space and distributed throughout the home.

Figure 10 – Crawl space clutter

Uninsulated plumbing could lead to frozen pipes in vented crawl spaces. A number of sweating pipes were found in crawl spaces during the site visits.

- **Clutter**

Damp clutter, including old clothes, cardboard boxes and garbage, was found in many crawl spaces (Figure 10). All but three inspected crawl spaces had interior access hatches which made it convenient for the occupants to use the crawl spaces for storage.

3.4 Bathroom and Kitchen Exhaust Fans, Heat Recovery Ventilators and Blower Door Tests

- **Bathroom Fans**

The majority of bathroom exhaust fans installed in the homes were rated at 70 cubic feet of air per minute (CFM). Properly operating exhaust fans help remove moisture from the bathroom during showers. An exhaust fan flow meter was used to measure the actual CFM exhausted by the fans. The results of the measured CFM flow of the bathroom fans and the type of fan are shown in Table 2.

Table 2: Bathroom Fan CFM

Inspection Number	Main or Master Bedroom Bath Fan CFM Flow	2nd Bath Fan CFM Flow	Kitchen Fan Type
1-1	0	26	Recirculating
1-2	0	-	Recirculating
2-3	37	40	Vented to outside
2-4	0	14	Recirculating
2-5	23	Non-operational	Vented to outside, but non-operational
2-6	43	31	Vented to outside
2-7	34	37	Vented to outside
2-8	26	-	Recirculating
3-1	14	-	Recirculating
3-4	17	0	Vented to outside
3-6	25	17	Recirculating
3-7	17	0	Vented to outside, but non-operational
3-8	Non-operational	Non-operational	Vented to outside, but ineffective
4-1	Non-operational	-	No fan

As can be seen from Table 2, none of the bathroom exhaust fans operated at or near 70CFM. This situation has been commonly seen in all housing types, regardless of economic strata. Five of the fans appeared to work but measured 0 CFM flow. Four of the bathroom exhaust fans were simply non-operational. All the fans vented to the outside rather than into the attic cavity. In addition, the bathroom fans were noisy and occupants tend to not use noisy fans.

Kitchen Fans Only four operational kitchen fans vented to the outside. Three other kitchen fans vented to the outside but were either non-operational or ineffective. Six fans were recirculating. One home had no kitchen fan.

- **Heat Recovery Ventilators** Three homes were retrofitted with heat recovery ventilators. However, two systems were turned-off and one system had separate ductwork not tied to the furnace. The supply and return grilles to the house were inappropriately located in the living room and dining area, just around the corner from each other (Figure 11). The proximity of the two grilles short-circuits air supply around the home. The other two systems were tied into the furnace ductwork, providing fresh air throughout the home.

Figure 11 – Supply and return registers for HRV units (both registers were sealed with tape for the blower door test)

Two older homes that only received exterior inspections had HRV systems. Both fresh air intakes to the systems were clogged with debris (Figure 12), preventing fresh air from being pulled into the house.

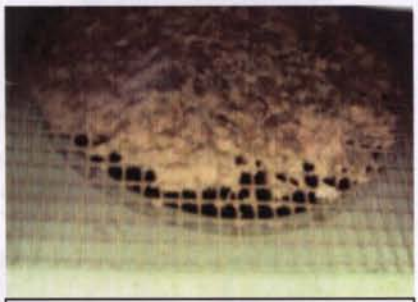

Figure 12 - Clogged HRV intake

Two older, twenty plus years old, inspected homes had supply only ventilation systems. The systems consisted of a 6" diameter duct tied to the return side of the furnace (Figure 13). Whenever the air handler operated, fresh air was pulled into the home, mixed with the return air to the furnace and distributed throughout the home. Blocked air intakes were also found on these systems.

- **Blower Door Tests**

Blower door tests measure the air tightness of homes. Moisture problems can occur in homes that are too tight and do not have a ventilation system. Homes that leak much air waste energy dollars and cause comfort problems.

Two older homes and one new home were measured with the blower door. One house (about 8 years old) measured 2100 CFM50 with a significant amount of leakage around the floor registers. This was the same house with a flooded crawl space. The second house (about 4 years old) measured 1600 CFM50. This home had an HRV system that was turned-off. The new home measured 625 CFM50. This home was very tight and had an HRV system that provided fresh air to all of the living spaces.
The MLRHA recently purchased a blower door to measure the air tightness of their homes.

Figure 13 – Fresh air intake from outside to return side of furnace

3.5 Attics

Inspected attics were insulated to R30 with either batts or blown fiberglass insulation (Figure 14). No mold or water problems were found in any of the attics. Attics were well vented with a combination of ridge and soffit vents with insulation baffles installed over the top plate. Only one home had a mold problem at the junction of the wall and ceiling on an exterior wall.

Figure 14 – R30 attic insulation

3.6 Plumbing Leaks

Eight of the inspected homes had plumbing leaks. A disconnected drain line had flooded the crawl space in home 3-4 (Figure 15). The MLRHA immediately took steps to correct this problem. All the remaining plumbing issues were minor leaks under kitchen sinks or water pressure tanks (Figure 16). A clogged bathroom drain was found in another home.

Figure 15 – Flooded crawl space due to disconnected drain line

3.7 Occupant Education

Occupant lifestyles may also contribute to moisture and other indoor air quality issues. Occupants should be trained in the following areas to assist them in solving and eliminating moisture and mold problems in their homes. Occupant related items found during the site visits included:

- dirty or missing furnace filters,
- clogged fresh air intakes,
- turned-off HRV systems,
- clutter and garbage in crawl spaces,
- unused bathroom exhaust fans,
- missing downspouts and leaders
- minor leaks that are not reported.

Figure 16 – Mold under kitchen sink due to previous leak

3.8 New Homes

Three homes under construction were inspected for energy efficient building practices, indoor air quality issues and potential mold and moisture problems (Figure 17).

Figure 17 – Typical new home

Homes are framed with 2" x 6" studs and insulated with R21 batts. Raised heel or energy trusses are used to provide full attic insulation over top plates reducing the potential for cold spots and

potential mold growth at the ceiling/wall juncture (Figure 18). Foundations consist of ICF with R20 insulation (Figure 19).

Furnaces are 90% efficient and are direct vent sealed combustion DVSC (Figure 20). All air for combustion is drawn from the outside rather than from the interior of the home with a DVSC appliance, preventing backdrafting from occurring. Water heaters are electric. HRV systems are used and tied into the furnace distribution system (Figure 21). Bathrooms have exhaust fans vented to the outside. Kitchens have recirculating fans.

Figure 18 – Raised heel trusses with insulation baffles

Figure 19 – ICF system (R20)

A recently completed home was tested with the blower door and measured 625 CFM50 which is very tight. However, good indoor air quality should be maintained with the HRV system, the DVSC furnace and the electric water heater. The home should be comfortable with very reasonable fuel bills.

Site drainage around the homes appeared to be good. All homes have (or will) have gutter systems.

Figure 20 – Direct vent sealed combustion furnace

SECTION 4 – TECHNICAL RECOMMENDATIONS

Recommendations based on the site visit findings follow:

4.1 Site Drainage

Efforts are needed to divert rain water/snow melt away from the house foundation and keeping water out of crawl spaces and half basements. This may be difficult to accomplish given that many of these homes are located within 6" of grade. These efforts should include:

- Overall site grading to prevent water flow toward the houses. Construct swales and French drains to help in some cases.
- Grade directly at the foundation to ensure a soil pitch away from the foundations.
- Fill in holes and dips found adjacent to foundations even if site drainage work cannot

Figure 21 – Heat recovery ventilator

be done or is not planned for the immediate future (Figure 22).

Figure 22 – Low spot adjacent to foundation. Note flip-up leader.

4.2 Rainwater/Snow Melt Management

Fifteen homes had gutter system problems. Eight of these had no gutter systems. Occupants remove downspouts after MLRHA installs them, thus rainwater management problems add to poor site drainage problems.

- Install gutter systems on homes without gutters. Rainwater and snow melt must be removed away from the house to reduce the amount of water that affects the foundations (Figure 23). Minnesota winters and forested building sites can be tough on gutter systems and require a commitment to routine inspection and cleaning. A gutter guard system can help keep debris out of the gutter, thus minimizing maintenance, while allowing water to drain into the gutter.

Figure 23– Missing leader

- Installing downspouts by screwing or pop-riveting the components together may make removal by the occupants more cumbersome. Installing straps that attach to the downspout and then to the home may also help prevent their removal.

- Continued use of flip-up leaders and splash blocks to direct water away from foundations.

- Instruct occupants on the importance of downspouts, flip-up leaders and splash blocks and maintaining these items in good condition.

Figure 24 – Typical vented crawl space

4.3 Crawl Spaces

The crawl space foundation walls are the thermal boundary in all the homes except for the two mobile homes and one house. The foundation walls are well insulated and ductwork and plumbing are located in the crawl space.

Six crawl spaces were not vented; six were vented (Figure 24). The only break in the thermal boundary is the venting. The vents allow cold air to enter the crawl space in the winter causing wasted energy dollars, while increasing the potential for frozen pipes. This is analogous to opening a window in a heated room. Crawl space vents do not facilitate drying in the summer. If the crawl spaces are to be vented, then the floors above the

crawl spaces should be insulated and air sealed with all mechanical systems (ductwork, plumbing) located above the insulation.

The inspected crawl spaces with insulated foundation walls should be considered conditioned space. As such, the following recommendations are made:

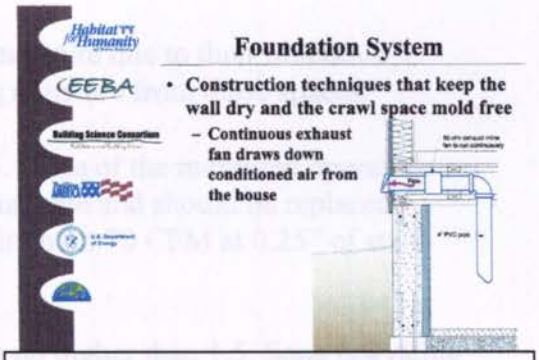

Figure 25– Mechanical crawl space exhaust system

- Existing crawl space vents should be sealed and made watertight.
- Crawl space foundation wall and rim joist insulation should be inspected and replaced where missing.
- No return air should be drawn from the crawl space. All return air grilles in crawl spaces should be sealed. Joints in return air ductwork should be sealed with duct mastic or butyl-backed aluminum tape especially designed for duct joints. Do not use cloth duct tape or aluminum foil tape to seal joints because of their history of adhesive failure.
- The soil surface in the crawl spaces without concrete pads should be inspected for a continuous and sealed ground cover such as a polyethylene sheet of other vapor-proof material. Ground covers should be installed in crawl spaces where missing.
- Keep crawl spaces under a slightly positive or negative pressure with respect to conditioning and indoor air quality.

  ➢ **Crawl Space under Positive Pressure** Leave existing supply air registers open to the crawl space or install cut in supply air registers where not present. This puts the crawl space under a positive pressure while intentionally providing conditioned air to the crawl space.

  ➢ **Crawl Space under Negative Pressure** Seal all supply air registers and install exhaust fan in foundation wall (Figure 25). The fan should be rated for continuous operation and draw about 50 CFM from the crawl space. Conditioned air will naturally be drawn into the crawl space from the living space through joints and holes in the floor.

  The advantage of this system is that crawl space contaminants will be drawn to the outside rather than into the home. Please note that this strategy will not help dry a wet crawl space. It is a method to condition the crawl space and improve indoor air quality.

4.4 Bathroom and Kitchen Exhaust Fans

Bathrooms and kitchens generate large amounts of moisture due to their functions. Properly operating exhaust fans are key to removing moisture from these spaces.

- Immediately replace inoperable exhaust fans. None of the measured operating exhaust fans performed at their desired exhaust rate and should be replaced. Newly installed fans should be rated for a minimum 70 CFM at 0.25" of static pressure.
- New bathroom fans should have sone ratings no higher than 1.5. Sone is a rating for sound – the lower the sone rating, the quieter then fan. Occupants tend not to use loud fans because of the noise. Low-sone fans include Broan *Solitaire* and Panasonic *WhisperCeiling* and *WhisperLite* series. Low-sone fans generally cost between $75 and $100.
- Replace existing bathroom light/fan switch with a fan delay timer. The fan delay timer is a two function switch that is typically wired to a fan and a light. When the switch is turned on, both the light and exhaust fan go on. When the switch is turned off, the light goes off but the fan continues to operate for an extended period of time. The extended period of time can be adjusted from 1 to 60 minutes. Fan delay timers are about $35.
- A 60 minute timer switch may be used when the bathroom fan has a separate on/off switch. Timer switches cost between $15 and $50.
- Kitchen recirculating fans should also be replaced with fans that vent to the outside. Kitchen exhaust fans should be rated at 150 CFM. Specifications for recirculating kitchen fans in the new homes should be changed to vented kitchen fans. Kitchen fans generally do not have sone ratings. However the *Broan Allure* series has sone ratings ranging from 0.4 to 1.5.
- Periodically inspect all bathroom and kitchen exhaust fan ducts. Ensure that exhaust ducts are properly attached and sealed to the exhaust fan housing. All ducts should terminate outside the house and not below roof vents.
- If exhaust venting is taken through the roof eaves, ensure that the ducts terminate and are sealed to a properly design eave vent designed for exhaust fan termination.

4.5 Dryer Vents

- Periodically inspect dryer vents. The following conditions should be corrected when found:

- crimped dryer vent (Figure 26)
- disconnected dryer vents
- venting to some space other than to the outside of the building
- replacing plastic ribbed dyer vents

Figure 26 – Crimped dryer vent

4.6 Heat Recovery Ventilators (HRVs)

The program to install HRV's in newly constructed and older homes should continue.

- The systems in the newly constructed homes appear to be well designed. They provide fresh air to all of the living spaces and exhaust air from the bathrooms and kitchens.

- Make efforts to utilize existing ductwork for HRVs installed in older homes rather than installing separate HRV ductwork. When separate ductwork was used, fresh air was not supplied throughout the home.

- Place HRV units so the filters are easily accessible for cleaning.

Figure 27– Garbage thrown in crawl space

- Instruct occupants of the importance of using their HRV systems and cleaning filters regularly.

- Regularly inspect and clean fresh air intakes.

4.7 Occupant Education

Occupant cooperation minimizes moisture and other indoor air quality (IAQ) problems.

- When fans are operable and vented to the outside, instruct occupants to use bathroom and kitchen exhaust fans during and after bathing and cooking activities to remove moisture from these spaces.

- Inform occupants not to use crawl spaces for storage or as a receptacle for garbage (Figure 27), unless they place storage boxes on slightly raised platforms or in plastic bins placed away from foundation walls.

- Discourage the use of rugs in half basements. If used, the occupants should inspect the underside of the rugs periodically for the presence of mold. Discard rugs with.

- Do not place mattresses directly on floors in half basements; raise the rugs off the floor to allow air circulation underneath them.
- Change furnace filters monthly during the winter; change HRV filters monthly throughout the year.
- Promptly report plumbing leaks. Recognize the difference between plumbing leaks and sweaty pipes and fixtures. Wipe-up moisture from sweating pipes and fixtures.

Figure 28 – Rusted panned return duct in crawl space.

- Promptly report disconnected or rusted ducts (Figure 28).
- Instruct occupants on proper use of sump pumps. Periodically inspect sump pumps. Water should not be visible in the well.

Inspection Number	Address	HUD Program	Building Age	Occupancy	Foundation Type	Framing and Model Type	Heat Type	Basement or Crawl Space framing moisture content	Site Drainage Problems	Gutter System Problems	Leaks from Exterior	Wet Basement or Crawl Space	Plumbing Problems	Bathroom Problems	Exterior Wall/Ceiling Problems	Attic Problems	Visible Mold	Exhaust Ventilation Problems	Bathroom Ventilation (CFM)
1-1	16845 Ojibwe Drive	LR	7 Years	8	ICF Basement/ Crawl Space	Wood Frame Split Level	Forced-Air Propane Furnace	12% Floor Joists, 9% Sheathing	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	0, 26
1-2	15820 Migizi Drive	LR	8 Years	Unknown	ICF Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	0
2-1	15900 Migizi Drive	MH	7 Years	Unknown	Concrete Block Basement	Wood Frame 1-1/2 Story	Forced-Air Propane Furnace	NA	No	Yes	No Interior Inspection								
2-2	19500 Whitefish Drive	MH	4 Years	Unknown	Concrete Block Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	NA	Yes	No	No Interior Inspection								
2-3	19700 Whitefish Drive	MH	4 Years	3	Concrete Block Crawl Space	Modular Wood Frame Ranch	Forced-Air Propane Furnace	13% Floor Joists	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	37, 40
2-4	3365 Sam Drive	LR	7 Years	4	ICF Basement/ Crawl Space	Wood Frame Split Level	Forced-Air Propane Furnace	6%	Yes	Yes	No	No	Yes	No	No	Not Inspected	No	Yes	0, 14
2-5	3240 Chiminising Drive	MH	7 Years	5	Concrete Pad and Skirting	Mobile Home	Forced-Air Propane Furnace	Not Inspected	Yes	Yes	No	Not Inspected	Yes	Yes	Yes	NA	No	Yes	0, 23
2-6	36586 208th Place	MH	4 Years	4	Concrete Block Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	6-7% Floor Joists	Yes	Yes	No	Yes	No	No	No	NA	No	Yes	31, 43
2-7	House Number Unknown 208th Place	MH	4 Years	3	Concrete Block Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	NA	Yes	Yes	No	Yes	No	No	No	NA	No	No	34, 37
2-8	13606 State Highway 65	LR	9 Years	2	ICF Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	13%	Yes	No	No	Yes	No	No	No	NA	Yes	No	26
3-1	46454 Alma Razor	LR	9 Years	3	Concrete Block Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	15-16% Floor Joists	No	No	No	Yes	Yes	No	No	Not Inspected	Yes	No	14
3-2	14650 Grouse	Unknown	2 Years	Unknown	Poured Concrete Basement	Modular Wood Frame Ranch	Forced-Air Propane Furnace	Not Inspected	Yes	No	No Interior Inspection								
3-3	405C Grouse, Route 3	MH	2 Years	Unknown	Poured Concrete Basement	Modular Wood Frame Ranch	Forced-Air Propane Furnace	Not Inspected	Yes	No	No Interior Inspection								
3-4	Rural Route 2 Box 242	LR	12 Years	3	Poured Concrete Basement/ Crawl Space	Wood Frame 1-1/2 Stories	Combination Wood Stove/ Propane Forced-Air Furnace	Not Tested	No	Yes	No	Yes	Yes	No	No	Not Inspected	No	Yes	0, 17
3-5	64014 Unknown Street	Unknown	NA	Unknown	Concrete Block Basement	Wood Frame Ranch	Forced-Air Propane Furnace	NA	Yes	Yes	No Interior Inspection								
3-6	Unknown	LR	9 Years	8	Concrete Block Basement/ Crawl Space	Wood Frame Split Level	Forced-Air Propane Furnace	Not Tested	Yes	Yes	No	No	Yes	Yes	No	No	No	Yes	17, 25
3-7	Rural Route 2 Box 244	LR	21 Years	9	Concrete Block Basement/ Crawl Space	Wood Frame 1-1/2 Stories	Combination Wood Stove/ Propane Forced-Air Furnace	Not Tested	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	Yes	Yes	0, 14
3-8	Rural Route 2 Box Number Unknown	LR	21 Years	7	Concrete Block Basement/ Crawl Space	Wood Frame 1-1/2 Stories	Combination Wood Stove/ Propane Forced-Air Furnace	Not Tested	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	Yes	Yes	NA
3-9	39838 Van Gordon Road	Unknown	2 Years	Unknown	Concrete Pad and Skirting	Mobile Home	Forced-Air Propane Furnace	NA	Yes	Yes	No	No	No	No	No	NA	No	No	NA
1-Apr	1611 Ataage Drive	MH	30 Years	3	Concrete Block Crawl Space	Wood Frame Ranch	Forced-Air Propane Furnace	Not Tested	Yes	Yes	Yes	Yes	No	No	No	Not Inspected	Yes	Yes	Not Inspected

Inspection Number: 1-1
Address: 16845 Ojibwe Drive
Age: 7 years
House Type: Split level
Condition: Occupied (8)
Bedrooms: 4
Foundation: Half basement (finished), crawl space; ICF
Heat Type: Forced air, propane
Construction: 2" x 6" stick-built

Figure 1 – 16845 Ojibwe Drive

Mold and Moisture Conditions: The house had experienced flooding in the crawl space. Standing water was present in parts of the crawl space as was moldy debris (Figure 2). Mold was found on the drywall between the crawl space and house (Figure 3). Mold was also present in the utility room and spare room of the half basement (Figure 4). The furnace room was open to the crawl space and there was no door on the furnace room thus the crawl space was open to the entire house. The filter slot was open in the utility room (Figure 5). In addition, there was a hole in the living room floor to the crawl space. Mold was also found in the lower level bathroom.

Figure 2- Standing water/debris in crawl space

Figure 3 – Mold on furnace room wall near crawl space

Figure 4 - Mold at base of spare room in half basement

Figure 5- Open filter slot

Rainwater Management: Gutters and downspouts with flip-up leaders were added in the fall of 2002 (Figure 6). The house was re-graded around the crawl space. Both measures were done to prevent water from draining into the crawl space. Site drainage was still quite flat on the side of the basement wall with two window wells.

Figure 6 - Flip-up leader

Crawl Space/Basement: Standing water was found in parts of the crawl space (water entry was prior to the measures being implemented). Water was present in the open sump. The crawl space was not vented. Heating ducts were not sealed or insulated. The floor of the crawl space was concrete. Insulated concrete forms (ICF) were used for the foundation. The crawl space measurements were:

Temperature:	72°F
Relative Humidity:	50%
Foundation Wall Surface Temp:	63°F
Floor Joist Moisture Content:	12%
Floor Sheathing Moisture Content:	9%

Bathroom/Kitchen: No mold was found in the bathrooms and kitchen, although there was some rot under the kitchen sink. There was no toe-kick supply air register. A recirculating fan was present in the kitchen. The downstairs bath fan measured 26 CFM. The upstairs bath fan measured 0 CFM, although it made a lot of noise).

Attic: There was no attic access hatch. A combination ridge and soffit vents were used to vent the attic.

Occupant Notes: There were eight occupants in this home, four adults and four children. One adult was an expectant mother. One adult smoked cigarettes. There were no reported health problems.

Recommendations:

- Get water and debris out of crawl space.
- Make sump pump operational.
- Continue re-grading work around half basement.
- Replace moldy drywall.
- Seal return air duct joints and place cap over furnace filter slot.
- Install new bath fans and a kitchen exhaust fan that vents to the outside.

Inspection Number: 1-2
Address: 15820 Migizi Drive
Age: 8 years
House Type: Ranch
Condition: Occupants unknown
Bedrooms: 3
Foundation: Crawl space (ICF)
Heat Type: Forced air, propane
Construction: 2" x 6" stick-built

Figure 1 – 15820 Migizi Drive

Mold and Moisture Conditions: There was approximately 6" of standing water in the crawl space (Figure 2). Some mold was found on the bathroom wall between the toilet and bathtub and also in a corner in the master bedroom. A washing machine was present, but no clothes dryer was in the home. Some clothes were hung to dry in the home. Given the amount of water in the crawl space, it was surprising to find so little mold in the home.

Figure 2 – Water in crawl space

Rainwater Management: The house was slab-on-grade and it sat very low to the ground. Site drainage was very poor and flat. There were no gutters or downspouts on the home.

Crawl Space: Approximately 6" of standing water was found in the crawl space. Wood in the crawl space could not be inspected, but the floor was sagging under the water heater and washer. It appeared that poor site drainage caused the water. The one crawl space vent appeared to be a retrofit (Figure 3).

Figure 3 – Lone crawl space vent

Blower Door Test: The house measured 2100 CFM50 with the blower door, which is considered fairly tight. There was however, significant leakage around the duct boots.

Bathroom/Kitchen: The kitchen fan was a recirculating one. The bathroom exhaust fan measured 0 CFM, although it made a lot of noise and was vented outside through a roof cap. Some mold was found on the wall between the toilet and bathtub (Figure 4). There a washing machine in the home, but no dryer. Clothes were hung to dry in the

Figure 4 – Mold on bathroom wall

home. The floor under the furnace and water heater appeared to be rotted.

Attic: The attic was insulated with R30 fiberglass batt. The roof sheathing was in good condition with no visible mold. Baffles were present over the top plate for air circulation.

Master Bedroom: Mold was found in a corner of the master bedroom and could be due to poor air circulation and/or a lack of insulation at the corner (wind-washing). Although the window was double glazed, the exterior lite was broken, thus the window acted like a single pane window.

Heating System: The furnace was a downflow unit with both supply and return in the crawl space. Combustion air was provided to the furnace closet with 4" diameter, insulated flex (Figure 5). The water heater was natural draft with rust on the water heater vent.

Figure 5 - Combustion air intake (typical)

Occupant Notes: Occupants were not home.

Recommendations:

- Remove water from crawl space and dry it out. Mechanical ventilation may be required to dry the crawl space.
- Install gutters and downspouts and direct water away from home.
- Re-grade around home where possible (will be difficult because house is sitting so low).
- Inspect for mold and rotted sheathing or floor joists, especially under the water heater.
- Seal all duct joints.
- Replace the broken window in the master bedroom.
- Inspect exterior corner of master bedroom where mold is present - check for holes in sheathing or the corner that may allowing air infiltration.
- Replace bathroom fan and install kitchen exhaust fan that vents to the outside.
- Seal duct boots (the portions of the ducts that convert the round duct to a rectangular shape to fit the registers) to sub-floor.
- Seal crawl space vent and provide exhaust only ventilation in crawl space.

Inspection Number: 2-1
Address: 15900 Migizi Drive
Age: 7 years
House Type: 1 ½ stories
Condition: Occupants Unknown
Bedrooms: 4
Foundation: Basement (concrete block)
Heat Type: Forced air (Direct vent sealed combustion), propane
Construction: 2" x 6" stick-built

Figure 1 – 15900 Migizi Drive

Occupants were not home. A visual inspection of the exterior of the home was made. Mold had been reported on the knee walls on the second floor. It was not possible to determine whether the basement had water problems.

Site drainage looked good and gutters were present, however, leaders were missing (Figure 2). Polyethylene material was used as foundation wall waterproofing. Much the polyethylene was ripped and missing from the above grade foundation wall (Figure 3).

Figure 2 - Missing leader

Figure 3 – Basement window well. Note polyethylene material on block wall.

Inspection Number: 2-2
Address: 19500 Whitefish Dr.
Age: 4 years
House Type: Ranch
Condition: Occupied
Bedrooms: 3
Foundation: Crawl space
Heat Type: Forced air, propane
Construction: 2" x 6" modular

Figure 1 – 19500 Whitefish Drive

Occupants were not home. A visual inspection of the exterior of the home was made. The inspectors were unable to determine whether mold was a problem in the home.

Site drainage was fairly flat with a sand pit between the house and front walk that could trap water. Gutters and flip-up leaders were present. The home had a vented crawl space. An extender hose was on the sump pump outlet moving water away from the foundation (Figure 2).

Figure 2 – Sump pump extender hose

Inspection Number: 2-3
Address: 19700 Whitefish Dr.
Age: 4 years
House Type: Ranch
Condition: Occupied (3)
Bedrooms: 3
Foundation: Crawl space
Heat Type: Forced air, propane
Construction: 2" x 6" modular

Figure 1 – 19700 Whitefish Drive

Mold and Moisture Conditions: Corners of foundation wall in crawl space were wet (Figure 2). Some mold was found on the insulation dam around the attic access hatch. Occupant complained of window condensation problems during the winter.

Figure 2 – Damp corner in crawl space

Rainwater Management: Site drainage was fairly flat around the home with a low spot under the front porch. Gutters were present, but downspouts were missing. The downspouts had previously been replaced three times.

Crawl Space: Crawl space foundation walls were concrete block with R10 exterior rigid foam insulation. The crawl space floor consisted of sand over a ground cover. The crawl space was vented.

Crawl space corners were damp probably due to a site drainage problem. No standing water was found on the floor of the crawl space. The crawl space measurements were:

Temperature:	70°F
Relative Humidity:	54%
Dew Point Temp:	53°F
Foundation Wall Surface Temp:	58°F
Wood Moisture Content:	13%

Figure 3 – Supply air register in crawl space

Mechanicals were present in the crawl space. An open supply and return grille were present in their respective trunk lines (Figure 3). Branch return lines were panned.

Blower Door Test: The house measured 1600 CFM50 with the blower door, which was considered fairly tight.

Bathroom/Kitchen: The kitchen fan vented to the outside. The main bathroom exhaust fan measured 40 CFM and the master bedroom exhaust fan measured 37 CFM, although both fans were rated for 70 CFM.

Attic: Some mold was found on the insulation dam around the attic hatch (Figure 4). The attic was insulated with R30 blown fiberglass. The roof sheathing was in good condition with no visible mold. Baffles were present over the top plate for air circulation.

Figure 4 – Mold on insulation dam

Heating System: The direct vent sealed combustion furnace was a downflow unit with both supply and return in the crawl space. It was 92% efficient and propane fired, but the furnace filter was quite dirty. The water heater was electric.

A heat recovery ventilation (HRV) unit was installed in the home but not connected to the furnace ductwork (Figure 5). The HRV was turned off when the home was inspected, yet appeared to have never been used previously. The HRV provided supply air to the living room. Return air was drawn from the dining area. Because of the proximity of the supply and return grilles, there was some short-circuiting of the air and fresh air was not reaching the bedrooms (Figure 6).

Figure 5 – HRV unit

Occupant Notes: Three occupants in this home, one adult and two children, reported no health problems.

Figure 6 – Supply and return registers for HRV units (both registers were sealed with tape for the blower door test)

Recommendations:

- Re-grade around home and re-install downspouts.
- Seal both supply and return air grilles in crawl space.
- Seal and insulate crawl space vents
- Provide an exhaust only fan for the crawl space.
- Air-seal around attic hatch.
- Instruct occupants on the importance of using their HRV system and routinely changing the furnace filter.

Inspection Number: 2-4
Address: 3365 Sam Drive
Age: 7 years
House Type: Split-level
Condition: Occupied (4)
Bedrooms: 4
Foundation: Half basement (finished), crawl space; ICF
Heat Type: Forced air, propane
Construction: 2" x 6" stick-built

Figure 1 – 3365 Sam Drive

Mold and Moisture Conditions: No mold was found, but standing water was found beneath the water pressure tank (Figure 2) and under the kitchen sink, both due to leaks.

Figure 2 – Leak from water pressure tank

Rainwater Management: Site drainage was fairly good except for a low spot on the back of the house. Gutters and downspouts were not present and drip lines could be seen around the home.

Crawl Space: The crawl space had a concrete floor and was dry, but debris was present. The sump pump appeared to be operational. There was an open supply register but no return air grille (Figure 3). The crawl space was not vented. The crawl space measurements were:

Temperature:	74°F
Relative Humidity:	41%
Dew Point Temp:	50°F
Foundation Wall Surface Temp:	70°F
Wood Moisture Content:	6%

Figure 3 – Open supply air register in crawl space

Bathroom/Kitchen: The kitchen fan was recirculating. Standing water was found under the kitchen sink and the base had started to rot. The upstairs bathroom exhaust fan measured 0 CFM and the lower level exhaust fan measured 14 CFM. Both fans were rated for 70 CFM.

Attic: The attic was not inspected.

Heating System: The propane furnace was power vented (80% efficient) and had a very dirty filter. The propane water heater was natural draft. Standing water was found under the water pressure tank. Signs of flame rollout were visible on the water heater jacket which is a fire hazard (Figure 4).

Figure 4 – Signs of flame rollout on water heater jacket

Occupant Notes: There were four occupants in this home, two adults and two children. One child was reported to have chronic bronchitis and breathing problems.

Recommendations:

- Correct flame rollout condition (this condition was going to be corrected immediately by the housing authority).
- Repair or replace water pressure tank.
- Fix leak beneath kitchen sink and clean mold if present.
- Replace both bathroom exhaust fans.
- Install kitchen exhaust fan that vents to the outside.
- Install gutters and downspouts.
- Close the open supply air register in the crawl space.

Inspection Number: 2-5
Address: 3240 Chiminising Dr.
Age: 7 years
House Type: Mobile home
Condition: Occupied (5)
Bedrooms: 3
Foundation: Crawl space
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 – 3240 Chiminising Dr.

Mold and Moisture Conditions: No mold was found. Evidence of a previous roof leak was visible in the living room. In the main bathroom the drain was disconnected (Figure 2).

Rainwater Management: Site drainage was flat. No gutters or downspouts were present.

Figure 2 – Disconnected drain beneath bathroom sink

Crawl Space: The space beneath the mobile home was enclosed by skirting. The mobile home sat on a concrete pad. The floor above the crawl space was heated. Insulated heating ducts were present and lying on the ground. The crawl space could not be inspected given space restrictions, but it had a musty smell. Standing water or mold could not be seen.

Bathroom/Kitchen/Living Room: The kitchen fan vented to the outside, but was non-operational. The main bathroom exhaust fan was non-operational. The master bedroom bathroom exhaust fan measured 23 CFM. The drain was disconnected beneath the main bathroom sink. Water stains were visible on the living room ceiling from a previous roof leak that has been repaired (Figure 3).

Figure 3 – Water stains on living room ceiling

Heating System: Both the furnace and water heater were fired with propane.

Occupant Notes: The five occupants in this home, one adult and four children, reported no health problems.

Recommendations:

- Reconnect drain beneath bathroom sink.
- Replace bathroom and kitchen exhaust fans and vent to the outside.
- Inspect crawl space for signs of water damage.
- Install gutters and downspouts and drain water away from home.
- Repair or replace stained living room ceiling.

Inspection Number: 2-6
Address: 36586 208th Pl.
Age: 4 years
House Type: Ranch
Condition: Occupied (4)
Bedrooms: 3
Foundation: Crawl space, concrete block
Heat Type: Forced air, propane
Construction: 2" x 6" modular

Figure 1 – 36586 208th Pl.

Mold and Moisture Conditions: No mold was found in the home. The crawl space floor and foundation wall adjacent to the garage were damp.

Rainwater Management: Site grading was flat. Gutters were present, but two downspouts were missing.

Crawl Space: The foundation walls were concrete block insulated on the exterior with 2" of extruded polystyrene foam insulation. The crawl space was vented. The occupant must open and close vents on a seasonal basis. The floor of the crawl space was sand over a polyethylene ground cover. The foundation wall and sand on the garage side of the crawl space near the sump pump were wet (Figure 2). The supply air duct had an open register to the crawl space., but no return air grille on the return trunk. The crawl space measurements were:

Figure 2 – Wet sand near crawl space

Temperature:	75°F
Relative Humidity:	34%
Dew Point Temp:	46°F
Foundation Wall Surface Temp:	65°F
Wood Moisture Content:	6%-7% (floor joists)

Figure 3 – HRV installed over furnace

Bathroom/Kitchen: The kitchen fan vented to the outside. The master bedroom bathroom exhaust fan measured 43 CFM and the main bathroom exhaust fan measured 31 CFM. Both fans are rated for 70 CFM.

Attic: Attic was not inspected.

Heating System: The furnace was propane fired and 80% efficient. The water heater was electric. A heat recovery ventilator (HRV) was also present and was controlled by a humidistat (Figure 3). The HRV was "on" and set at 35% RH. The HRV had a main

supply vent to the living room and a main return from the dining area. However, branch lines connected the HRV to the furnace so that fresh air was provided to the other living spaces in the home.

Occupant Notes: The four occupants in this home, two adult smokers and two children, reported no health problems.

Recommendations:

- Check sump pump for proper operation.
- Replace missing downspouts.
- Re-grade around home, especially on the garage side.
- Close supply air register to crawl space.
- Seal crawl space vents.
- Provide exhaust only fan in crawl space.

Inspection Number: 2-7
Address: 208th Pl.
Age: 4 years
House Type: Ranch
Condition: Occupied (3)
Bedrooms: 3
Foundation: Crawl space
Heat Type: Forced air, propane
Construction: 2" x 6" modular

Figure 1 - 208th Pl.

Mold and Moisture Conditions: No mold was found in the home. The crawl space floor adjacent to the garage was damp.

Rainwater Management: Site grading was flat. Gutters were present, but some downspouts were missing.

Crawl Space: The foundation walls were concrete block insulated on the exterior with 2" of extruded polystyrene foam insulation. All crawl space vents were closed. The crawl space floor was sand over a polyethylene ground cover. The sand on the garage side of the crawl space near the sump pump was wet. The supply air duct register to the crawl was closed. There was no return air grille on the return trunk. The crawl space measurements were:

Temperature:	74°F
Relative Humidity:	40%
Dew Point Temp:	48°F
Foundation Wall Surface Temp:	61°F

Bathroom/Kitchen: The kitchen fan vented to the outside. The master bedroom bathroom exhaust fan measured 34 CFM and the main bathroom exhaust fan measured 37 CFM. Both fans were rated for 70 CFM.

Attic: The attic was not inspected.

Heating System: The furnace was propane fired and 80% efficient and had a quite dirty filter. The water heater was electric. A heat recovery ventilator (HRV) was controlled by a humidistat. The HRV was turned off and was set at 20% relative humidity (RH). The HRV had a main supply vent to the living room and a main return from the dining area. However, branch lines connected the HRV to the furnace so that fresh air was provided to the other living spaces in the home.

Occupant Notes: The three occupants in this home, one adult smoker and two children, had no reported health problems.

Recommendations:

- Check sump pump for proper operation.
- Replace missing downspouts.
- Re-grade around home, especially on the garage side.
- Keep the supply air register to the crawl space closed.
- Seal crawl space vents.
- Provide exhaust only fan in crawl space.
- Replace furnace filter.

Inspection Number: 2-8
Address: 13606 State Highway 65
Age: 9 years
House Type: Ranch
Condition: Occupied (2)
Bedrooms: 2
Foundation: Crawl space, ICF
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 – 13606 State Highway 65

Mold and Moisture Conditions: The crawl space floor was wet (Figure 2). The debris present in the crawl space was moldy. Mold was also found on the floor sheathing beneath the bathtub (Figure 3).

New drain tile was installed last year to solve drainage problems around the home. In addition, pipes had frozen and burst causing additional water problems in the crawl space.

Figure 2 – Water in crawl space with debris

Rainwater Management: Site drainage looked good, except for the driveway adjacent to the house that may hold water against the house. Gutters and downspouts were present.

Crawl Space: The concrete floor of the crawl space was wet. Debris was moldy. The water line from the flooding was visible on the wall. Floor sheathing under the bathtub was moldy. Supply ducts are located in the crawl space – a supply register could not be found. The crawl space measurements were:

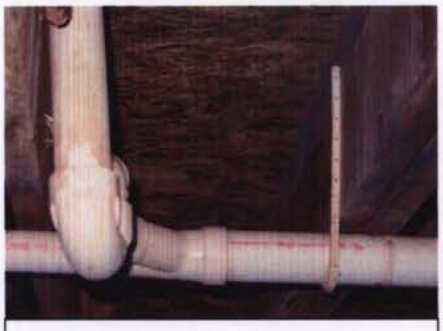

Figure 3 – Moldy sheathing under bathtub.

Temperature:	76°F
Relative Humidity:	41%
Dew Point Temp:	53°F
Foundation Wall Surface Temp:	62°F
Wood Moisture Content:	13%

Bathroom/Kitchen: Kitchen fan was a recirculating type. The bathroom exhaust fan measured 26 CFM. A previous mold problem in bathroom had been corrected; gypsum board was replaced and painted.

Attic: The attic was not inspected.

Heating System: The furnace was propane fired and 80% efficient. The filter was very clean. The water heater was natural draft propane. A washer was in the home, but no clothes dryer.

Occupant Notes: The two occupants in this home, one adult smoker and one child, reported no health problems.

Recommendations:

- Dry-out crawl space and remove debris.
- Install exhaust only fan in crawl space.
- Install kitchen exhaust fan vented to outside.
- Replace bathroom exhaust fan and vent to outside.
- Clean mold from or replace the floor sheathing underneath the bathtub.
- Install supply register in the crawl space.

Figure 1 – 46454 Alma Razor

Inspection Number: 3-1
Address: 46454 Alma Razor
Age: 9 years
House Type: Ranch
Condition: Occupied (3)
Bedrooms: 3
Foundation: Crawl space, concrete block
Heat Type: Forced air, propane
Construction: 2" x 6"

Mold and Moisture Conditions: The crawl space floor was wet. Debris present in the crawl space was moldy (Figure 2). Mold was found on some window frames.

Figure 2 – Moldy debris in crawl space – note drip line beneath copper pipe

Rainwater Management: Site drainage was flat. Gutter, downspouts and flip-up leaders were present.

Crawl Space: Foundation walls are concrete block with interior R10 extruded polystyrene insulation. The crawl space smelled musty. The concrete floor was wet near the water pressure tank. Copper water lines were sweating. No sump pump was in the crawl space. Supply and return lines, both with open registers, were present in the crawl space (Figure 3). The crawl space was vented. The crawl space measurements were:

Temperature:	69°F
Relative Humidity:	58%
Dew Point Temp:	54°F
Foundation Wall Surface Temp:	61°F
Wood Moisture Content:	15%-16% (floor joists)

Bathroom/Kitchen: The kitchen fan was recirculating. The bathroom exhaust fan measured 14 CFM.

Figure 3 – Return air grille on crawl space – note dirt on grille.

Attic: The attic was not inspected.

Heating System: The furnace was propane fired and 80% efficient. The water heater was natural draft propane. A washer was present in the home, but no clothes dryer.

Occupant Notes: The three adult occupants were smokers, but reported no health problems.

Recommendations:

- Dry out crawl space and remove debris.
- Insulate water lines to prevent sweating.
- Seal crawl space vents.
- Seal supply and return registers in crawl space.
- Install exhaust only fan in crawl space.
- Install kitchen exhaust fan vented to outside.
- Replace bathroom exhaust fan.

Inspection Number: 3-2
Address: 14650 Grouse
Age: 2 years
House Type: Modular Ranch
Condition: Occupants unknown
Bedrooms: Unknown
Foundation: Basement, poured concrete
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 – 14650 Grouse

Occupants were not home. A visual inspection of the exterior of the home was made.

Site drainage was flat with some low spots around the foundation (Figure 2). Gutters and downspouts were present. The fresh air intake to the heat recovery ventilator (HRV) was clogged (Figure 3).

Figure 2 – Low spot at foundation.

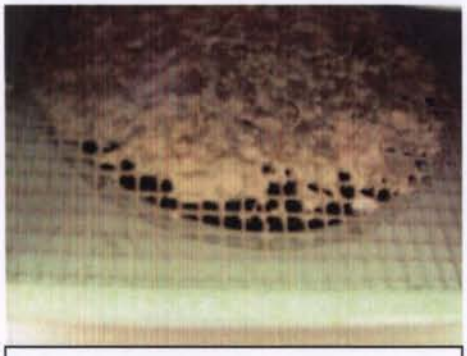

Figure 3 - Clogged HRV instake

Inspection Number: 3-3
Address: 405C Grouse, Rte. 3
Age: 2 years
House Type: Modular Ranch
Condition: Occupants unknown
Bedrooms: Unknown
Foundation: Basement, poured concrete
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 –405 Grouse, Rte. 3

Occupants were home, but indicated that they had no mold or moisture problems. An interior inspection of the home was not made. However, a visual inspection of the exterior of the home was made.

The home had a walk-out basement in the back where site drainage looked poor. It appeared that water draining from the sides of the home could collect at this point (Figure 2).

Figure 2 – Site drainage at rear of house poor

The fresh air intake to the HRV was clogged (Figures 3 and 4).

Figure 3 – Fresh air intake

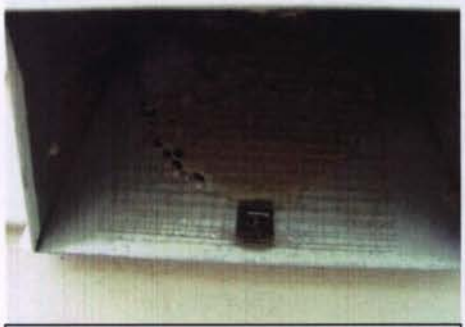

Figure 4 – Clogged fresh air intake to HRV

Inspection Number: 3-4
Address: Rural Rte. 2 Box 242
Age: 12 years
House Type: 1 – ½ stories
Condition: Occupied (3)
Bedrooms: 3
Foundation: Finished basement, crawl space poured concrete
Heat Type: Forced air, combination propane and wood
Construction: 2" x 6"

Figure 1 – Rural Rte. 2, Box 242

Mold and Moisture Conditions: A distinct odor could be detected upon entering the home. It was discovered that the kitchen sink drain had become disconnected and was flooding the crawl space (Figure 2). In addition, sewer gases from the septic system were backing-up into the home.

Figure 2 – Water in crawl space

Rainwater Management: Site drainage was flat. No gutter system was present on the home.

Basement/Crawl Space: The disconnected kitchen sink drain was discovered in the crawl space. Supply ducts were present in the crawl space, but it could not be determined if there was a supply air register. Temperature and moisture measurements were not taken in the crawl space.

Carpeting was used in one of the living spaces in the basement. A corner of the carpeting was pulled-back. No mold was found on either the carpeting or floor.

Figure 3 – Garbage in wood furnace

Bathroom/Kitchen: The kitchen fan vented to the outside. Signs of water damage were present beneath the kitchen sink. The main level bathroom exhaust fan measured 17 CFM. The downstairs bathroom exhaust fan measured 0 CFM.

Attic: The attic was not inspected.

Heating System: The furnace was combination wood/propane fired. It was apparent, however, that garbage was being burned in the unit (Figure 3). A central return was used for the furnace. The water heater was natural draft propane.

Occupant Notes: The three occupants in this home were two adults and one five-month-old child with reported breathing problems.

Recommendations:

- Fix kitchen drain, clean and dry out crawl space (this condition was going to be corrected immediately by the housing authority).
- Replace both bathroom exhaust fans.
- Install gutter system.
- Check and repair sewer system to prevent sewer gases from backing up into the home.

Inspection Number: 3-5
Address: 64014
Age: Unknown
House Type: Ranch
Condition: Occupants unknown
Bedrooms: Unknown
Foundation: Basement, concrete block
Heat Type: Forced air, propane
Construction: 2" x 6"

Occupants were not home. A visual inspection of the exterior of the home was made.

Site drainage was fairly good except for walk-out basement in rear of home. It appeared that water could collect at this point from drainage along side of home. Gutters and downspouts were present, but some of the leaders were missing or not connected (Figure 2).

Figure 1 – 64014

Figure 2 – Disconnected leader

Inspection Number: 3-6
Address: Unknown
Age: 9 years
House Type: Split level
Condition: Occupied (8)
Bedrooms: 5
Foundation: Finished basement, crawl space concrete block
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 - Unknown

Mold and Moisture Conditions: The crawl space was dry, but water supply pipes were sweating.

Rainwater Management: Site drainage was fairly good. Erosion was visible along the pad for the side door (Figure 2). There were no gutters or downspouts.

Figure 2 – Erosion along pad for side door

Crawl Space: The crawl space was dry except for sweating on the water supply pipes. The foundation wall was insulated on the interior with R10 extruded polystyrene. The floor of the crawl space was concrete. There was quite a bit of clutter in the crawl space. The space was vented. Though the supply and return ducts were located in the crawl space, no supply or return air registers were found. The crawl space measurements were:

Temperature:	76
Relative Humidity:	37
Dew Point Temp:	48
Foundation Wall Surface Temp:	61°F

Bathroom/Kitchen: The kitchen fan was a recirculating type. The main level bathroom fan measured 25 CFM. The lower level bathroom fan measured 17 CFM. Standing water was found in the bathroom sink, possibly from a clogged drain.

Figure 3 – Signs of flame roll-out on water heater

Heating System: The furnace was fired with propane and was 80% efficient. There was no filter in the filter slot. The water heater was propane fired and there were signs of flame roll-out (Figure 3). A washer and dryer were present in the home. The dryer had a 90° angle to the outside vent that severely restricted air

flow through the vent (Figure 4).

Attic: The attic was insulated to R30 with fiberglass batts (Figure 5). No mold was found on the roof sheathing. A combination of soffit and ridge vents was used for attic ventilation. Insulation baffles were used over the top plate to maintain an air space between the insulation and roof sheathing.

Figure 4 – 90° bend at dryer exhaust outlet

Occupant Notes: There were eight occupants in this home, two adults and six children. One of the adults was a smoker. One child was reported to have breathing problems.

Figure 5 – R30 attic insulation

Recommendations:

- Correct flame rollout condition (this condition was going to be corrected immediately by the housing authority).
- Install gutters and downspouts.
- Insulate water supply lines in crawl space.
- Seal crawl space vents.
- Provide exhaust only fan for crawl space
- Install kitchen exhaust fan that vents to the outside.
- Correct dryer vent situation.
- Repair clogged bathroom drain.
- Replace bathroom exhaust fans with more efficient, timed fans.
- Clean out debris from crawl space.

Inspection Number: 3-7
Address: Rural Rte. 2, Box 244
Age: 21 years
House Type: 1 – ½ stories
Condition: Occupied (9)
Bedrooms: 4
Foundation: Finished basement, crawl space concrete block
Heat Type: Forced air combination, propane/wood stove
Construction: 2" x 6" wood frame

Figure 1 – Rural Rte. 2, Box 244

Mold and Moisture Conditions: The crawl space was wet and filled with clutter. Mold was found in both bathrooms and lower level bedrooms. Water damage was found under the kitchen sink.

Rainwater Management: Site drainage was flat. There were no gutters or downspouts. Water drained to a concrete pad adjacent to the crawl space (Figure 2).

Figure 2 – Water drains next to the crawl space

Crawl Space/Basement: The crawl space smelled musty. The ground was wet, as were the first couple of courses of concrete blocks (Figure 3). The crawl space was not vented and full of clutter. Moisture and temperature measurements were not taken in the crawl space. The foundation walls were insulated with exterior R10 extruded polystyrene.

Bathroom/Kitchen: The kitchen fan vented to the outside, but was non-operational. Standing water was found in a pan beneath the kitchen sink. The main level bathroom exhaust fan measured 17 CFM. The lower level bathroom exhaust fan measured 0 CFM. Both bathrooms were very moldy (Figure 4). Mold was also found in the lower level bedrooms.

Figure 3 – Wet crawl space with debris

Figure 4 – Mold in bathroom

Heating System: Furnace was combination propane/wood fired. Water heater was propane fired. The furnace room was full of clutter and poses a fire hazard (Figure 5). Despite the age of the house (20 years), there was a ventilation system. A 6" diameter duct connected to the return side of the furnace. Whenever the air handler was operating, fresh air was drawn in from the outside and mixed with the return air (Figure 5).

Figure 5 – Clutter in furnace room. Note 6" diameter duct in background – fresh air supply to return side of furnace

Occupant Notes: There were nine occupants in this home, three adults and six children. One child was reported to have breathing problems.

Recommendations:

- Instruct occupants to remove clutter from furnace room.
- Install gutters and downspouts.
- Re-grade around home to direct water away from foundation.
- Clean-out debris from crawl space.
- Install exhaust only fan in crawl space.
- Replace kitchen exhaust fan and vent to the outside.
- Replace both bathroom exhaust fans.
- Clean mold in bathrooms and lower bedrooms.
- Repair kitchen sink leak.

Inspection Number: 3-8
Address: Rural Rte. 2, Box unknown
Age: 21 years
House Type: 1 – ½ stories
Condition: Occupied (7)
Bedrooms: 4
Foundation: Finished basement, crawl space, concrete block
Heat Type: Forced air combination, propane, wood stove
Construction: 2" x 6" wood frame

Figure 1 – Rural Rte. 2, Box ?

Mold and Moisture Conditions: The house had mold and moisture problems. The crawl space was wet and filled with clutter (Figure 2). A panned return located in the crawl space had rusted out (Figure 3). Crawl space air was drawn into the furnace distribution system whenever the air handler was on. Water damage was found in the utility room due to a plumbing leak. Water damage was also found on the bathroom wall between the toilet and bathtub. Mold was found under the kitchen sink where a toe-kick supply air register was located. The dryer vent was disconnected.

Figure 2 – Crawl space clutter

Rainwater Management: Site drainage was flat. There were no gutters or downspouts except over the front door. Water drained along the foundation walls.

Crawl Space/Basement: The crawl space smelled musty. The crawl space floor was very wet as were areas of the concrete block wall. The crawl space was not vented and clutter was present. A panned return had totally rusted-out. Moisture and temperature measurements were not taken in the crawl space. The foundation walls are insulated with exterior R10 extruded polystyrene.

Figure 3 – Rusted panned return

Bathroom/Kitchen: The kitchen fan vented to the outside, but did not appear to be effective. Mold was found under the sink above a toe-kick supply air register (Figure 4). Both bathroom fans were non-operational.

Figure 4 – Mold beneath kitchen sink

Water damage was found in the utility room from a previous drainage problem (Figure 5). The dryer vent was disconnected.

Figure 5 – Water damage behind washing machine

Heating System: The furnace was a combination propane/wood unit. The water heater was propane fired. There is a 6" diameter duct from the outside to the return side of the furnace (Figure 6). However, the fresh air intake was clogged (Figure 7). The water heater vent was rusted indicating a flue condensation problem (Figure 8).

Occupant Notes: There were seven occupants in this home, one adult and six children. The adult was a smoker. One child was reported to have breathing problems.

Figure 6 – Fresh air intake

Recommendations:

- Repair and seal all return ducts in crawl space.
- Install gutters and downspouts.
- Re-grade around home to direct water away from foundation.
- Clean-out debris from crawl space.
- Install exhaust only fan in crawl space.
- Replace kitchen exhaust fan and vent to the outside.
- Replace both bathroom exhaust fans.
- Replace vent on water heater and check for proper draft.
- Replace rusted flue.
- Clean mold from under the sink.
- Reconnect dryer vent.

Figure 7 – Clogged fresh air intake

Figure 8 – Rusted flue

Inspection Number: 3-9
Address: 39838 Van Gordon
Age: 2 years
House Type: Mobile home
Condition: Occupants unknown
Bedrooms: 3
Foundation: Crawl space
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 – 39838 Van Gordon

Mold and Moisture Conditions: Pipes froze and burst in late winter 2003. There was considerable water damage done to the belly of the mobile home. No mold was found during the site inspection.

Rainwater Management: Site drainage was flat. There were no gutters or downspouts.

Crawl Space: The mobile home was enclosed by vented skirting. There was a good ground cover. Given limited space, a thorough inspection of the crawl space could not be made; however, everything appeared to be dry.

Bathroom/Kitchen: The kitchen fan vented to the outside. Both bathroom fans were operational, but their CFM exhausts were not measured.

Heating System: The furnace was sealed combustion and fired by propane. The filter was very dirty. Water heater could not be inspected. There was no washer and dryer in the home.

Recommendations:

- Install gutters and downspouts and direct water away from home.
- Replace furnace filter.

Inspection Number: 4-1
Address: 1611 Ataage Drive
Age: 30 years
House Type: Ranch
Condition: Occupied (3)
Bedrooms: 2
Foundation: Crawl space,concrete block
Heat Type: Forced air, propane
Construction: 2" x 6"

Figure 1 – 1611 Ataage Drive

Mold and Moisture Conditions: The ground in the crawl space was wet. The ductwork was rusting. The access hatch to the crawl space was below grade. The water damage in the furnace room was due to a previous leak.

Figure 2 – Missing leader on downspout

Figure 3 – Disconnected gutter

Rainwater Management: Site drainage was flat. Leaders were not present on the downspouts (Figure 2). Some gutters were blocked with debris. One gutter was disconnected (Figure 3).

Crawl Space: Access to the crawl space was through an exterior hatch that was partially below grade. There was no ground cover and the ground was wet (Figure 4). Ductwork was rusting. Neither the foundation walls nor the floor above the crawl space were insulated. The crawl space was vented. Due to the limited crawl space height, a thorough inspection and crawl space measurements could not be made.

Figure 4 – Wet crawl space

Bathroom/Kitchen: There was no exhaust fan in the kitchen. Signs of a previous leak were visible under the kitchen sink. The bathroom exhaust fan was non-operational. Water stains were present behind the washing machine (Figure 5).

Figure 5 – Water stains behind washer

Attic: The attic was not inspected.

Heating System: The furnace was propane fired and 80% efficient. The water heater was natural draft and propane fired. Signs of a previous roof leak were visible on the ceiling around the flue (Figure 6). The home had central air-conditioning.

Figure 6 – Water stains from previous roof leak

Occupant Notes: The three occupants, two adults and one child, had no reported health problems. One adult was an expectant mother. One adult was a smoker.

Recommendations:

- Clean and repair gutters.
- Install leaders on downspouts.
- Re-grade around crawl space access hatch.
- Dry out the crawl space and install and seal the crawl space ground cover.
- Replace rusted ductwork and seal all joints.
- Insulate foundation walls with R10 extruded polystyrene insulation.
- Install kitchen exhaust fan vented to the outside.
- Replace bathroom fan and vent to outside.